the hand and fingers in attempting to draw it. The "drawing" was simply the vaguest and most general imitation of the teacher's movements, not the tracing of a mental picture. And the attempt was no better when a "copy" was made by myself on the paper—a rough outline drawing of a man, etc. There was no semblance of conformity between the child's drawing and the copy. Farther, while she could identify the copy and name the animal, she could not identify her own effort, except so far as she remembered what object she set out to make.

But in the next week (early in the twenty-seventh month) a change came. I drew a rough human figure, naming the parts in succession as they were made: she suddenly seemed to catch the idea of tracing each part, and she now for the first time began to make figures with vertical and horizontal proportion; i.e., she followed the order she saw me take: head (circle), body (ellipse) below, legs (two straight lines) further below, hands (two lines) at the sides of the body. It is all done in the crudest fashion, but that is due to the lack of muscular co-ordination. With the simplification of the figure by breaking it up into parts came also the idea of *tracery imitation*, and its imperfect execution.

As yet, however, it is limited to two or three copies — objects which she sees me make. That it is not now simply imitation of my movements is evident from the fact that she does not imitate my movements: she looks intently upon the figure which I make, not at my movements, and then strives to imitate the figure with movements of her own very different from mine. But she has not generalized the idea away from particular figures, for she can not trace at all an altogether new figure in right lines. Further, she traces these particular figures just as well without written copies before her: *here, therefore, is the rise of the tracery imitation of her own mental picture* — a fact of great theoretical interest.

This illustrates again the point so strangely overlooked by writers on the rise of volition that the earliest voluntary acts are not voluntary movements. The thing pictured and willed here is not a movement, it is a figure — man, bird, dog. This figure suggests (stimulates) its motor associates. It is only later that the muscular movement becomes conscious end.

In the nature of the movements which the child has made in this series of drawings there is a marked change and development. There is growth from angular straight lines to curves, from movements one way exclusively to reverse movements, and an increasing tendency to complex intricate figures, which last probably results from greatly increased ease, variety, and rapidity of movement. At first she made only sweeping "arm-movements," then began to flex the wrist somewhat, and now, with no teaching, she manipulates the pencil with her fingers considerably. This seems to give support to the opinion of professional writing-teachers that the "arm-movement" is most natural and effective for purposes of penmanship.

Further, all her curves are made by movements from left to right going upward and from right to left downward. This is the method of our usual writing as contrasted with "backhand." She also prefers lateral to vertical movements on the paper. Her most frequent and easy "drawing" consists of a series of rapid right-and-left strokes almost parallel to one another.

J. MARK BALDWIN.

A FEW CHARACTERISTICS OF THE AVIAN BRAIN.[1]

WHEN we compare the brain of a crow or a titmouse with the brain of a snake or a turtle, it is no longer a marvel that birds bear towards their reptilian cousins the relation of intellectual giants to intellectual dwarfs. The cranium of reptiles is small, while the brain-cavity of birds is large, and, what is more pertinent, the whole of that cavity is filled with a compact brain mass. Not only that, but the cerebrum, the seat of the intellectual faculties, constitutes the major portion of that mass.

The cerebrum is composed of two lateral halves or hemispheres, which are so situated that they form a compact heart-shaped mass. The apex of this heart is directed towards the bill of the bird, while the notch is directed towards the tail. These hemispheres are unconvoluted, but the borders of some of the superficial lobes approach almost to the dignity of convolutions. Furthermore, a microscopic study of the brain reveals the fact that occasionally there occurs a blind convolution; i.e., an internal projection of gray matter without a concomitant surface convolution.

A microscopic study of the bird brain does not reveal a cerebral cortex similar to that of the human cerebrum. Here the cerebral cortex is represented by a thin hull containing several loosely aggregated cell-clusters. These cell clusters are constant and are homologous to corresponding clusters in the lizard brain.

Next in size to the cerebrum comes the cerebellum. Not only is it transversely convoluted, not only is it a cover for the medulla, but it is also partly wedged into the notch between the two halves of the cerebrum. This high development of the cerebellum of birds, coupled with the corresponding high development of the cerebellum of fishes, is a strong argument in favor of the hypothesis that the cerebellum functions as a co-ordinating centre for muscular movements.

Neurologically considered, birds are pre-eminently seeing animals, and all parts that appertain to vision are highly developed. The optic nerve is the largest cranial nerve, and the optic lobes are completely differentiated bodies. Even the third, fourth, and sixth cranial nerves, although quite small, are relatively larger than the corresponding nerves of the mammalian brain.

An extraordinary development of one set of organs is never accomplished but at the expense of some other set. In this case the organs of the sense of smell have been the martyrs. Although in the lower avian types the olfactory lobes are paired and conspicuous, yet in the highest types of birds they have been reduced to a small unpaired body which is partly imbedded in the base of the cerebrum.

These two facts lend support to the view that birds of prey find their food more by aid of the sense of sight than by aid of the sense of smell. The birds of prey are far from the lower end of the scale, and in all cases examined the olfactory lobes have been relatively smaller than the corresponding lobes of chickens, geese, turkeys, etc. I have not yet examined a buzzard's brain; but, judging by the figures of A. Bumm,[2] they have small, inconspicuous olfactory lobes.

From the above statements, we see that economy of space is evidenced in all parts of the avian brain. Indeed "progressive compactness" has played so important a part in the evolution of birds that there is a vast difference between the

[1] This is but a brief abstract of a portion of my paper upon the "Morphology of the Avian Brain," Journal of Comparative Neurology, vol. I., pp. 39-92, 107-134, 265-286, pl. V.-VIII., XIV.-XVI., XVIII.

[2] Das Groshirn der Vögel, Zeitschrift f. Wiss. Zoologie, Bd. xxxviii., 1883.

lowest avian brains, with their large projecting olfactory lobes and uncovered optic lobes, and the highest avian brains, with their small, inconspicuous olfactory lobes and covered optic lobes. The difference between these two extremes is almost as great as that between the brain of a lizard and the brain of the lowest type of birds. Yet there is no impassable gulf between these two extremes. All the intervening stages are supplied by the brains of the various avian groups. In reviewing this remarkable sequence, we are almost forced to believe that this tendency towards a progressive compactness of the brain existed long before the first bird was evolved. If this be true, then this tendency towards a progressive compactness of the brain, combined with a tendency to develop all parts appertaining to vision and to atrophy all parts appertaining to smell, will account for all the major differences between the avian and the reptilian brain.

Furthermore, within this class of animals, this "progressive compactness" of the brain is a factor of taxonomic importance. So far at least as major groups are concerned, a classification based upon it alone is, for the most part, in harmony with those classifications that are based upon other structural elements of birds.

Histologically considered, the bird brain is composed of nerve fibres, nerve cells, and neuroglia. Excepting the fornix and hippocampal commissures, all the principal commissures of the mammalian brain, corpus callosum included, are found in the avian brain. Poverty of space causes the omission, in this abstract, of the various other tracts of the bird brain.

Although in the bird brain the nerve cells present a great diversity of forms, yet they may all be grouped in the following classes: ganglionic cells, Deiter's corpuscles, fusiform or flask cells, pyramidal cells, and multipolar cells. The ganglionic cells are large bi-polar cells, which are never found outside of the root ganglia. Each extremity of the cell is prolonged into a nerve fibre. One fibre passes into the brain, the other into a nerve. In addition to the ordinary cell wall, each of these ganglionic cells is surrounded by a special nuclei-bearing sheath. Deiter's corpuscles are small cells, which are supplied with so small an amount of protoplasm that ordinary preparation reveals nothing but their nuclei. These minute cells are universally distributed. In the cerebellum, however, they are densely aggregated in a single lamina; while in the optic lobes they are densely aggregated in several concentric laminæ. The remaining three types are encountered throughout the brain; but in any single nidulus some type always predominates, often to the exclusion of the other two. The flask cells resemble a flask in shape, and when stained each cell presents a faintly stained nucleus, within which is a densely stained nucleolus. Such cells are supposed to function as sensory cells. The pyramidal cells are sub-pyramidal in outline. These cells stain densely, when each one presents a densely stained nucleus, within which is a densely stained nucleolus. Such cells are probably motor in function. The multipolar cells resemble distorted, many-branched, pyramidal cells. Such cells probably act as switch stations for nervous energy.

University of Cincinnati, Dec. 31, 1891. C. H. TURNER.

A NEW SABRE-TOOTHED TIGER FROM THE LOUP FORK TERTIARY OF KANSAS.

IN a collection of Loup Fork Tertiary fossils obtained by the writer from northern Kansas, is a right upper canine of *Machærodus*, apparently different from that of any of the known species of that genus.

The remains of several feline animals have been described from the Loup Fork, one of them (*Felis maxima*, Scott) being the largest of all known *Felidæ;* but none referred to the genus *Machærodus* has been announced. It may, however, yet appear that the *F. maxima* itself, which Professor Scott has but provisionally referred to the genus *Felis*, is a machærodont.

The Loup Fork canine includes the entire root and neck and the basal portion of the crown. As nearly as it is possible to judge, it represents an animal about as large as the puma, but it must be borne in mind that the size of an animal cannot be very positively and closely estimated from a part so highly specialized and so subject to variation in the ratio of its size to that of the body as is the canine in this genus. In any event, the tooth indicates an animal smaller than any of the known American Pleistocene species, unless it be *M. gracilis*, Cope, and considerably larger than the European Miocene *M. palmidens*, de Blainville.

As compared with the larger American species of *Machærodus* (*M. necator*, etc.), *M. gracilis* is characterized by the more compressed form of the basal portion of the upper canine; and this compression is said to be a marked feature. In the Loup Fork species, on the contrary, that tooth has greater relative thickness than in *M. necator*, the thickness of the tooth, at base of crown, being related to its breadth as 1 to 1.65, while the corresponding ratio in *M. necator* (taken from Cope's illustrations) is 1 to 2.2. In *M. neogæus* the ratio, derived from the measurements given by Burmeister, is 1 to 2.33.

The Loup Fork species may be known as *Machærodus crassidens.*

The canine of *M. crassidens* presents a gentle curvature and has its posterior cutting edge compressed and denticulated. Whether the anterior border was of similar character is uncertain. The form of a point-like downward prolongation of the surface of fracture on the anterior border of the crown may have been determined, when the tooth was broken, by the presence of a compressed border, but, if so, the contour of the preserved part of the crown does not indicate it. It is, at least, certain that a denticulate carina did not extend so far from the apex on the anterior as on the posterior border.

DIMENSIONS.

	Inches.
Breadth of crown of canine at base	1.14
Thickness of same	.69
Breadth of crown 1.5 inches above base (about)	.83
Thickness of crown at same (about)	.46
Length of root of canine (to origin of denticulated keel)	2.44
Length of canine, as restored (approximate)	5.45

Should new material prove that only the posterior margin of the canine is denticulated, the species would, in this respect, resemble the *Machærodus nestianus* of the upper Pliocene of Italy.

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NOTES AND NEWS.

THE Pennsylvania State Board of Health, at the instance of the Governor of Pennsylvania, has issued an invitation to the other State and the more important city boards of health, and to the American Public Health Association, to join in a conference with the officers of the World's Columbian Exposition at the city of Chicago, with the view to making an exhibit of the objects, methods, and results of the work of sanitary officials in this country.

— Mr. Charles S. Peirce has tendered his resignation as Assistant in the United States Coast and Geodetic Survey, to take effect Dec. 31. Mr. Peirce was first attached to the Survery about thirty